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Simulation of the Transport of Halogen Species from the Equatorial and Mid-Latitude Stratosphere to the Polar Stratosphere in a Two-Dimensional Model

Yuk L. Yung*, R.L. Shia*, M. Allen**, R.W. Zurek*, D. Crisp**, and J.S. Wen* (*California Institute of Technology, Pasadena, CA 91125; **Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109)

The bulk of O₃ destruction in the Antarctic stratosphere takes place in the lower stratosphere between 15 and 25 km. Both O₃ and the halogen reservoir species have their origins in the higher altitude region (20-30 km) in the equatorial and mid-latitude stratosphere. Using the Caltech-JPL two-dimensional residual circulation model, we investigate the growth of stratospheric halogen due to the increase of CFCI₃ and CF₂Cl₂.

The model has 18 latitudes (pole to pole) and 40 vertical layers (0 to 80 km). It was run from 1972 to 1988, with CFCI₃ and CF₂Cl₂ specified at the lower boundary

$$\begin{aligned} F_{11}(t) &= 96.5 + 9.0 \times t \\ F_{12}(t) &= 162.7 + 15.3 \times t \end{aligned}$$

where the mixing ratio is given in pptv and t is in years since 1972.

Preliminary conclusions are:

- Between 1976 and 1987 the column abundance of HF at 45°N increased by $6 \times 10^{14} \text{cm}^{-2}$ (see Fig. 1a) compared with an observed increase of $4 \times 10^{14} \text{cm}^{-2}$ (Zander *et al.*, 1987a).
- In the same period the column abundance of HCl at 45°N increased by $9 \times 10^{14} \text{cm}^{-2}$ (See Fig. 1c), compared with an observed increase of $7 \times 10^{14} \text{cm}^{-2}$ (Zander *et al.*, 1987b; Farmer, 1988 private communication).
- The corresponding increases in HF and HCl at 85°S are 1.4×10^{15} and $1.7 \times 10^{15} \text{cm}^{-2}$ respectively.
- The increase of free fluorine (F_x) and free chlorine (Cl_x) occurs above 25 km at midlatitudes, but occurs much deeper in the atmosphere at 85°S. (see Fig. 2).

References:

Zander, R., G. Roland, L. Delbouille, A. Sauval, C.B. Farmer and R.H. Norton, 1987a. Monitoring of the integrated column of hydrogen fluoride above Jungfraujoch Station since 1977 - the HF/HCl column ratio. *J. Atmos. Chem.* 5, 385-394.

Zander, R., G. Roland, L. Delbouille, A. Sauval, C.B. Farmer and R.H. Norton, 1987b. Column abundance and the long-term trend of hydrogen chloride (HCl) above the Jungfraujoch Station. *J. Atmos. Chem.* 5, 395-404.

Figure Caption:

Fig. 1a. Column abundance of HF at 45 N due to increase of CFCl_3 and CF_2Cl_2 in the atmosphere.

Fig. 1b. Same as Fig. 1a, for 85 S.

Fig. 1c,d. Same as Fig. 1a,b for HCl.

Fig. 2a. Vertical profile of F_x at 45 N and 85 S in Jan 1987 derived from CFCl_3 and CF_2Cl_2 .

Fig. 2b. Same as Fig. 2a, for October 1987.

Fig. 2c, d. Same as Fig 2a,b for Cl_x .

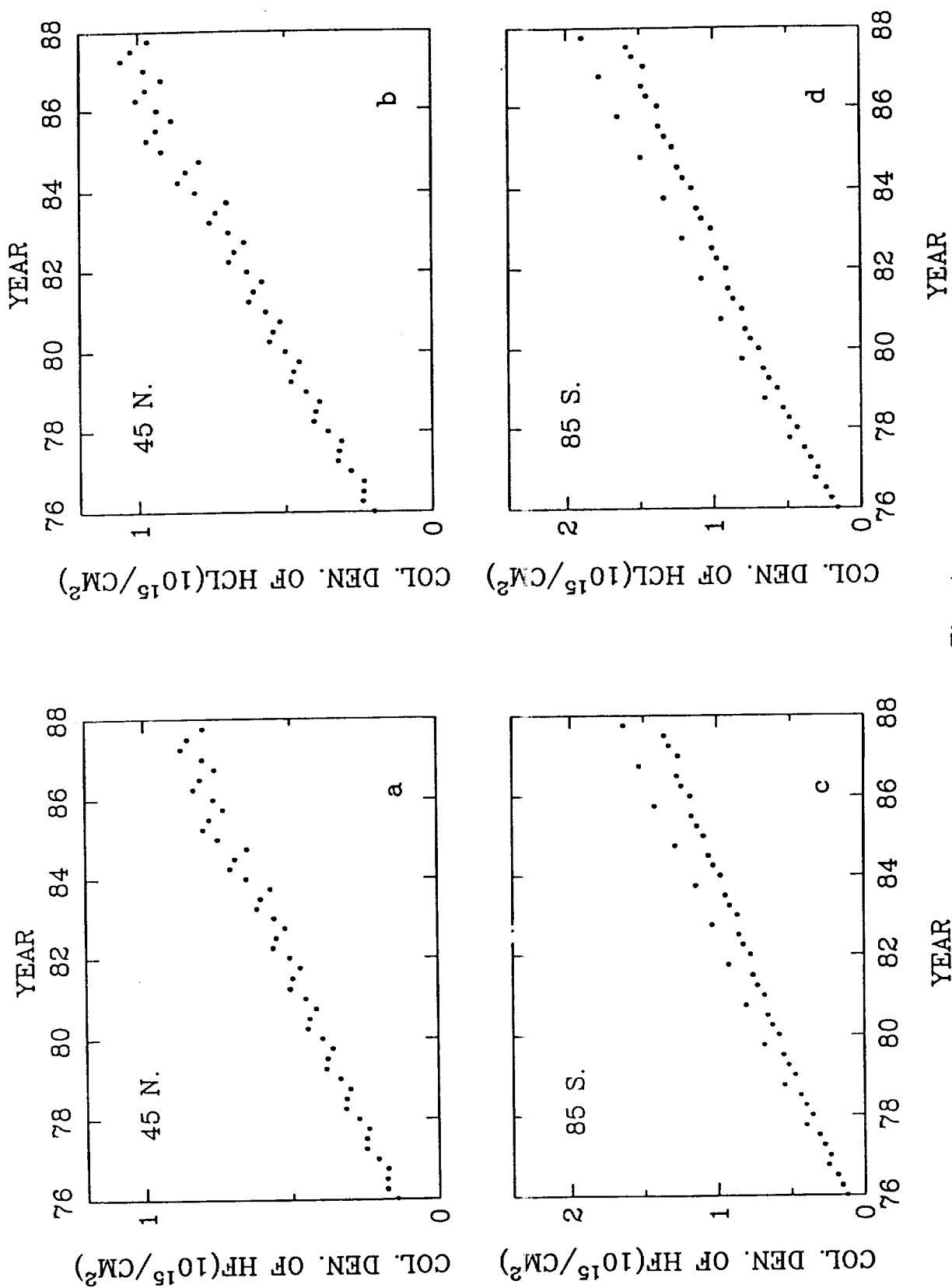
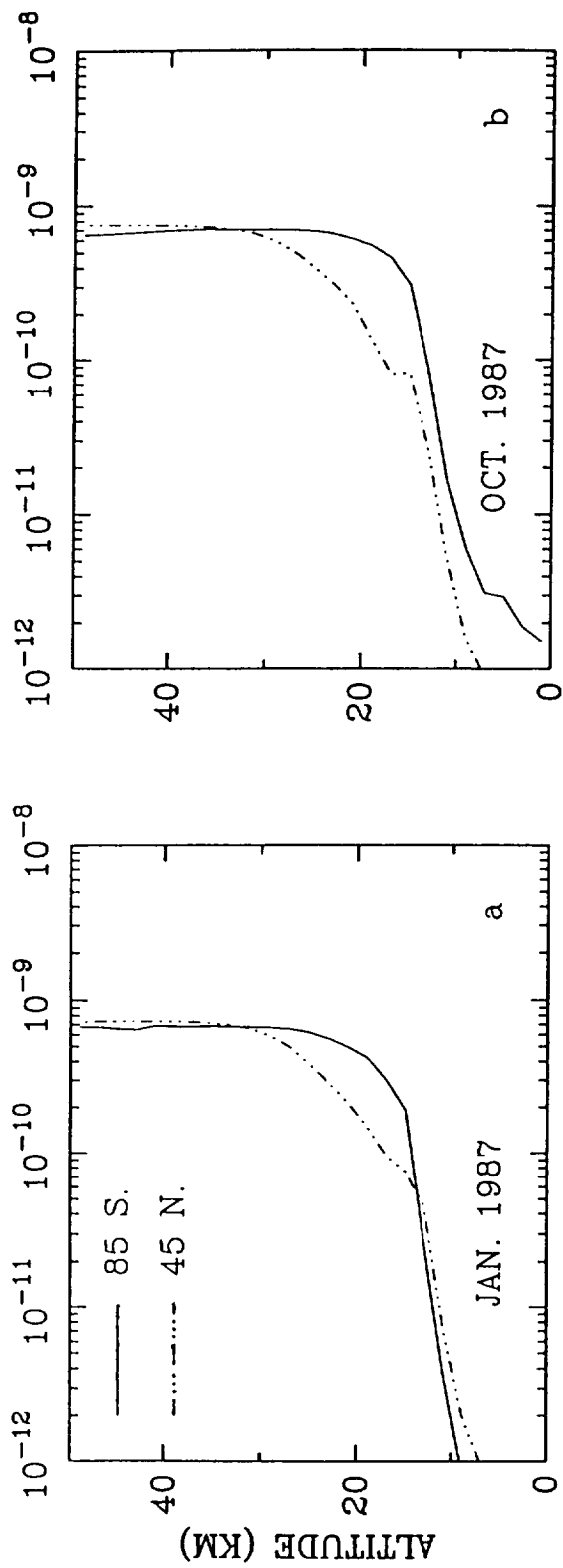


Fig. 1

MIXING RATIO OF F_x DERIVED FROM F11 AND F12



MIXING RATIO OF Cl_x DERIVED FROM F11 AND F12

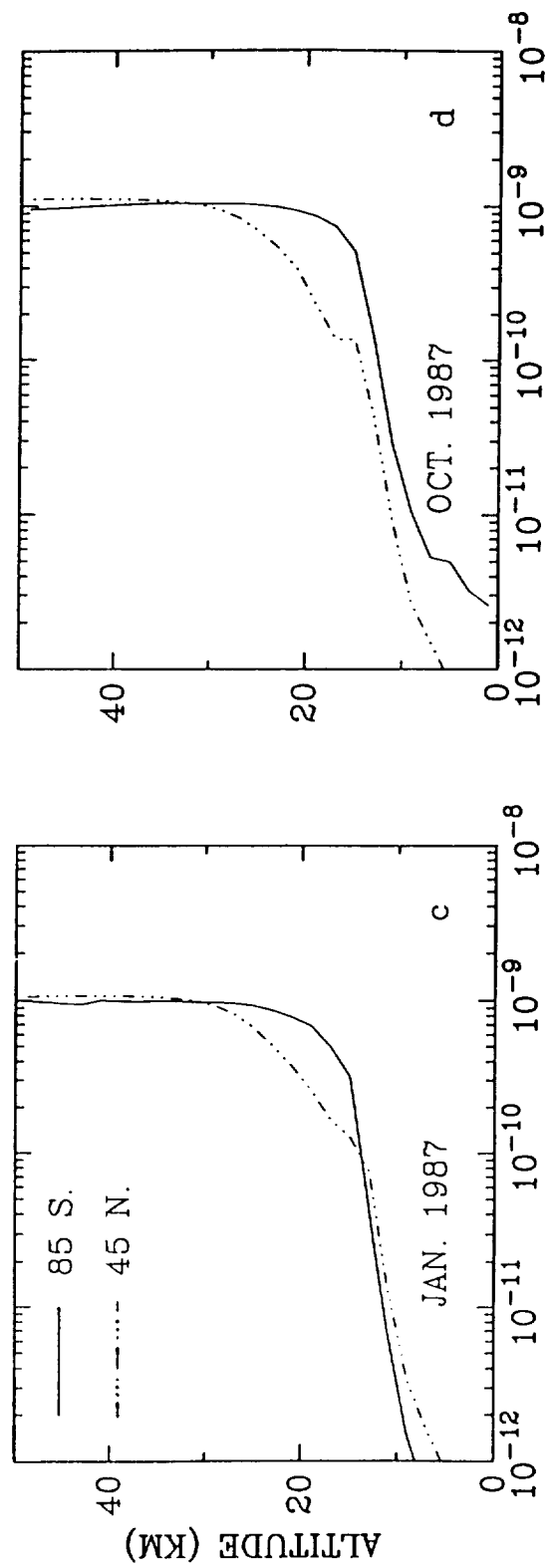


Fig. 2